Government Perspectives on Sustainability

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Advances in science and technology, the application of diverse government regulations and policies, and green business practices are all needed to advance sustainability. Biofuels production is a good case study to illustrate how government and business can work together to demonstrate sustainability in operation.

Agenda 21 is the plan of action endorsed by more than 178 countries at the United Nations Conference on Environment and Development (also know as the Earth Summit) in Rio de Janeiro, Brazil, in June 1992 *(1)*. Two of its principles are especially relevant for sustainability:

• The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

• In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Growing out of the World Summit on Sustainable Development (WSSD) ten years later in Johannesburg, South Africa, hundreds of partnerships to advance sustainable practices were created among government, business, and nongovernmental organizations (NGOs) (*2*). In the 17 years since the Rio meeting, however, national and international actors have not put the world on a sustainable path with respect to critical issues like energy use, greenhouse gas (GHG) emissions reductions, and protection of ecosystems. Why has it been so difficult to put sustainability principles into action? Will future government polices and business strategies be any different?

The traditional definition of sustainability calls for polices and strategies that meet society's present needs without compromising the ability of future generations to meet their own needs. This straightforward goal begs a number of practical questions — most importantly: "What kind of policies, strategies, and practices are needed to advance sustainability?" and "How will such changes impact economic development?" The complexity of making sustainability operational is illustrated by the current scientific and political debates on setting energy policy and promoting alternative fuels.

The starting point for achieving sustainability is asking the right questions. Why aim to merely reduce toxic waste when we can eliminate it with new chemicals and processes? Why handle and dispose of growing amounts of waste when we can more efficiently manage materials that eliminate, reduce or recycle waste? Many factors are forcing government and business to ask and address these kinds of questions.

For example, the Pollution Prevention Act of 1990 (PPA) placed the prevention or reduction of pollution at the center of national policy. The Act requires pollution that cannot be prevented to be treated in an environmentally safe manner. Even though reducing and/or recycling waste and pollution is a first step toward achieving sustainable practices, it is science and engineering skills and business practices that make sustainability happen.

Other drivers are also pushing government and business to ask the right questions about product development and

environmental stewardship. Society is facing serious constraints on water and other natural resources and rising prices for energy and materials. These rising prices, which stem from the constraints on the supply of natural resources, commodities, and energy sources, are pushing government and businesses to think more seriously about developing sustainability practices.

Looking ahead, the pressure on resources and pricing is not going to ease up. The environmental impact of economic growth in developing economies, notably in China, is adding additional pressure on governments to adopt more sustainable practices. According to the U.S. Energy Information Administration (EIA), China has emerged from being a net oil exporter in the early 1990s to become the world's third-largest net importer of oil in 2006. EIA forecasts that China's oil demand will grow by more than 800,000 bbl/d by 2009, or about 32% of the projected growth in world oil demand for the period *(3)*. Over the coming eight years, China also expects to build 562 new coal-fired plants, each with an anticipated life span of 50 years. And the American Chemistry Council has predicted that in the next decade, China's chemical industry will grow at an annual rate of 10.4%, compared to a worldwide growth rate of 3.6% *(4)*.

Since the Earth Summit conference in 1992, the sustainability landscape has significantly changed. New pressures related to resource availability, pricing, and environmental impacts are making the goal of sustainability more urgent. Now, more than ever, advances in science and technology, promulgation of a variety of government polices, regulations and incentives, and the adoption of green business practices are needed.

The rapidly expanding biofuels sector is one area affected by the growing global pressures for sustainable production. The environmental and economic viability of the evolving biofuel supply chain is a good case study to test how government and business can make sustainability operational.

Advances in science and technology

Science and technology drive change and are critical elements of any sustainability strategy. A 1997 study by the National Academy of Engineering recommended "the creative design of products, processes, systems and organizations, and the implementation of smart management strategies that effectively harness technologies and ideas to avoid environmental problems before they arise" *(5)*. A 2001 National Academy of Sciences study called on government and business to develop a "quantitative understanding of the global budget of materials widely used by humanity and how the lifecycles of these materials may be modified" *(6)*. Reflecting the growing scarcity of many natural resources and the rising prices of energy and commodities that impact almost every business sector, these studies underscore the importance of increasing the efficient use of energy and materials and avoiding negative environmental impacts.

The role of the U.S. Environmental Protection Agency (EPA) in advancing environmental science and technology has been critical in several areas. For many years, EPA has been active domestically and internationally in promoting sustainable development through green chemistry — *i.e.*, the development and use of chemicals that are less hazardous to human health and the environment, less toxic to organisms and ecosystems, less persistent or bioaccumulative in organisms or the environment, and inherently safer with respect to handling and use. Through the Presidential Green Chemistry Challenge Awards Program, EPA provides national recognition of outstanding chemical technologies that incorporate the principles of green chemistry into chemical design, manufacture, and use, and that have been or can be utilized by industry in achieving their pollution prevention goals.

Through Cooperative Research and Development Agreement (CRADA) partnerships with industry, EPA has

EPA PROGRAMS FOR SUSTAINABILITY

The Pollution Prevention Act is complemented by dozens of EPA policies and programs that have helped to shape new ways of manufacturing and doing business. For example:

Supply Chain and Manufacturing

Green Suppliers Network
www.greensuppliers.gov/gsn/page.gsn?id=about

Lean Manufacturing
www.epa.gov/innovation/lean/index.htm

Design for the Environment
www.epa.gov/dfe/pubs/projects/index.htm

Clean Processing
www.epa.gov/ORD/NRMRL/std/cppb/index.html

Green Chemistry Program
www.epa.gov/greenchemistry

Nanoscale Materials Stewardship Program
www.epa.gov/oppt/nano

Management and Performance

Sector Strategies Program
www.epa.gov/sectors/program.html

Performance Track
www.epa.gov/performancetrack

Preferential Purchasing

EnergyStar
www.energystar.gov

WaterSense
www.epa.gov/watersense

pioneered many new technologies and processes that advance sustainability. One such project between EPA's National Risk Management Laboratory (Cincinnati, OH) and Kreido Biofuels (Camarillo, CA) resulted in a spinning-tube processing system for the solvent-free synthesis of various ionic liquids with excellent conversions and high throughputs. This project addresses green chemistry concerns over solvent use while simultaneously maximizing product throughput and purity.

Over the past ten years, many industrial practices have incorporated principles of green chemistry and safer chemical substitutes (with "safer" usually meaning less toxic). However, a more sustainable approach is the use of biodegradable materials, a field that has developed rapidly in the past few years. Recent EPA work on small molecules is showing how biodegradability principles can be applied to chemicals that are used in high volumes. The design of molecules brings pollution prevention to the earliest phase in the long processes of commercializing new chemicals *(8)*.

EPA's initiative in computational toxicology (the advanced computer analysis of the molecular composition of chemicals to identify potential toxic risks) builds on technical advances in computer sciences, molecular biology, and chemistry. This effort has the potential to significantly increase the number of chemicals and types of biological interactions that can be evaluated, and would permit the evaluation of toxicity pathways across a wide range of concentrations and dose levels.

One of EPA's critical science and technology roles is developing the underlying knowledge base that allows decision-makers to choose sustainable alternatives. This means managing natural and other resources to provide the maximum sustainable level of services today and in the future. For decision-makers in industry, this means finding ways to enhance economic growth, while minimizing their environmental footprint.

This important goal of helping society make good decisions was identified in 1998 by the House Committee on Science in its report, "Unlocking Our Future" *(8)*. It states: "While acknowledging the continuing need for science and engineering in national security, health, and the economy, the challenges we face today cause us to propose that the scientific and engineering enterprise ought to move toward center stage in a fourth role: that of helping society make good decisions. We believe this role for science will take on increasing importance, as we face difficult decisions related to the environment."

To advance this objective, in 2007 EPA launched a Sustainability Research Strategy *(9)* with the dual goals of advancing an understanding of biological, physical and chemical interactions through a systems and lifecycle approach, and developing effective models, tools and metrics that enable decision-makers to achieve sustainable outcomes. These dual goals were applied to six cross-cutting research themes rather than the traditional single-media goals, such as clean air or clean water:

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- *renewable resource management* — aimed at improving the understanding of ecosystem processes and services, and developing and applying advanced systems models and tools for decision-making
- *nonrenewable resource management* — focusing on improving lifecycle assessment methodology and material flow analysis, and applying these analyses and models to assess the regional impacts of various energy sources on GHG and air toxic emissions and air quality
- *long-term chemical and biological impacts* — aimed at developing alternative chemicals and new industrial processes, as well as decision-support tools for evaluating the environmental dimensions of the new chemicals and processes; these efforts include new EPA initiatives related to the development and use of nanomaterials *(10)*
- *human-built systems and land use* — focusing on sustainable building design and efficiency and management of urban systems; an EPA research strategy supporting green building design is under development
- *economics and human behavior sciences* — linking research in economics and behavioral science, such as developing ecosystem-valuation methods, and analyzing the role of incentives in decision-making and the causes of market failures
- *information and decision support* — promoting sustainability metrics and environmental reporting.

Several of these themes converge to support collective federal efforts to promote sustainable development of the biofuels industry.

Government polices, regulations and incentives

Federal and state regulations and/or incentives are needed to make sustainability operational. The National Environmental Protection Act (NEPA), which was drafted in 1969 before EPA was established, requires that the federal government, in partnership with the states, "use all practicable means and measures … to create and maintain

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conditions under which man and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans." Subsequent legislation and executive orders have directed federal agencies to pursue sustainable management of federal facilities and to measure and report on the economic, environmental and social responsibilities of their operations.

For example, Executive Order 13423 of Jan. 24, 2007, "Strengthening Federal Environmental, Energy and Transportation Management," sets goals in the areas of energy efficiency, acquisitions, renewable energy, toxics reductions, recycling, sustainable buildings, electronics stewardship, vehicle fleets, and water conservation. The order directs the heads of federal agencies to implement sustainable practices in these areas, specifying that sustainable means "creating and maintaining conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations of Americans."

The Government Accountability Office (GAO) recently summarized the role that federal agencies are playing in complementing U.S. business goals of promoting global corporate social responsibility *(11)*.

For instance, environmental legislation can explicitly or indirectly set sustainability goals. The PPA aims to reduce pollution and specifically mentions "reformulation or redesign of products" as an approach to pollution reduction.

Using all of these approaches is important in promoting cost-effective sustainable practices and building partnerships with industry. In today's world, although regulating dangerous pollution and toxics certainly remains a necessary and vital task, eliminating the use of noxious materials altogether is a better, more-sustainable alternative. Similarly in the area of waste management, there is a shift in thinking away from managing *waste* to managing *materials*.

This new attitude reflects the principle behind many EPA programs that "developing new approaches for conserving resources, reducing the amount of toxic materials in society and the toxicity of materials that remain, and managing wastes properly can and should be an important part of responding to this challenge of making a more sustainable world" *(12)*.

Green business opportunities

Making sustainability operational requires cooperation between government and business. Although government-business relationships often entail tension and conflict, especially when new regulations are proposed, it is clear that firms can often grow their businesses through smart environmental management. General Electric's "Ecomagination" initiative and the rapid growth of investment capital in green technologies support the notion that protecting the environment can make good business sense.

The confluence of regulatory and public pressures on business and business opportunities is evident in the interviews of dozens of business leaders conducted by Esty and Winston *(13)*. They conclude that smart companies (which they call WaveRiders) are responding to growing economic, environmental, and social pressures by developing new business strategies that anticipate environmental issues and address them, stay ahead of new regulatory requirements, manage government mandates to gain advantage in the marketplace, design innovative or greener products, push suppliers to be better environmental stewards, set metrics and collect data to track progress, and partner with NGOs and other stakeholders.

This shift in business strategy sets the stage for a new framework for sustainable management and for government-business partnerships that promote environmental protection and support economic development. For example, GE and many other companies whose leaders Esty and Winston interviewed are strong advocates of federal legislation to address GHG emissions. This push by major industrial firms for new environmental regulations is not the norm.

Sustainability and biofuels

Sustainable biofuel production could enhance energy security, stimulate economic development, and reduce GHG emissions. Making the biofuel system sustainable is a test case for the convergence of advances in science and technology, the use of diverse government polices, regulations and incentives, and green business practices.

On the science side, both government and business recognize that advanced biofuels derived from non-food-related feedstocks are needed to meet biofuel goals in an environmentally sound manner. For the transition to second-generation biofuels, advances in science and technology are critical. The Departments of Energy (DOE) and Agriculture (USDA) are investing billions of dollars in crit-

ical research to develop cellulosic biofuels. Research on converting different feedstocks into liquid fuel requires enhancing the understanding of complex biological systems and developing conversion technologies that can be scaled up to support growing biofuel requirements. Extensive research is underway to promote advanced biofuels made from lignocellulosic feedstocks (*e.g.,* switchgrass, miscanthus, energy cane) rather than from food crops such as ethanol from corn *(14)*.

On the regulatory side, existing statutes and new mandates impact all parts of the biofuel supply chain (Figure 1), which is a complex system involving a variety of different feedstocks, conversion technologies, transport, storage, handling, and end use. Existing federal regulations concerning air, water, waste, toxic substances, and emergency response apply to nearly all elements of the biofuel system. As a result, many practices and facilities are subject to diverse federal laws, including NEPA and regulations under the PPA, the Clean Air Act (CAA), the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Federal Food, Drug and Cosmetic Act (FFDCA), and the Energy Policy Act of 2005 (EPAct). Within statutory limits, EPA and state and local environmental agencies are responsible for assessing and controlling air emissions, water discharges, toxic substances, microbial application, pesticide application, and waste disposal.

To help the growing biofuels sector become aware of and respond to existing regulations, EPA has prepared a compliance assistance manual containing a summary of applicable regulations for construction and operation of ethanol plants *(15)*. This manual provides extensive guidance that underscores the key roles played by EPA, states, and facility operators concerning critical human-health and environmental issues related to biofuel production. A similar assistance manual for biodiesel facilities is being developed.

Several provisions of the 2007 Energy Independence and Security Act (EISA) are helpful in specifically promoting sustainable biofuel production. From a sustainability perspective, it is the energy efficiency and environmental soundness of the entire biofuel system that determines the degree to which biofuels reduce reliance on fossil fuels. Given the reliance of the biofuel system on natural resources, assuring that the system proceeds in an environmentally sound manner is essential for its success, as well as for human health and ecosystem functioning *(16)*.

EISA calls for the development of cellulosic and other feedstocks that are less resource- and land-intensive. It aims to promote sustainable use of resources, including soil, water, energy, forest and land, and to ensure the protection of air, water, and soil quality. It mandates that by 2022, U.S. transportation fuels will include a minimum of 36 billion gal/yr of renewable fuels, including corn-based ethanol (with incentives capped at 15 billion gal/yr), ethanol derived from cellulosic materials, and other advanced biofuels derived from materials other than corn starch. It requires full lifecycle analysis of biofuel production and sets standards for renewable fuels to reduce GHG emissions by 20–60% below the GHG emissions levels of conventional fossil fuels.

To ensure appropriate checks and balances, EISA also requires EPA, in consultation with USDA and DOE, to assess and report to Congress every three years on the impact of current and future biofuel production in the U.S. and abroad. These reports must cover environmental issues (including air and water quality, pesticides, sediment, and nutrient and pathogen levels), conservation issues (including soil conservation, water availability, energy recovery from secondary materials, and ecosystem health and biodiversity) and growth and use of cultivated invasive or noxious plants

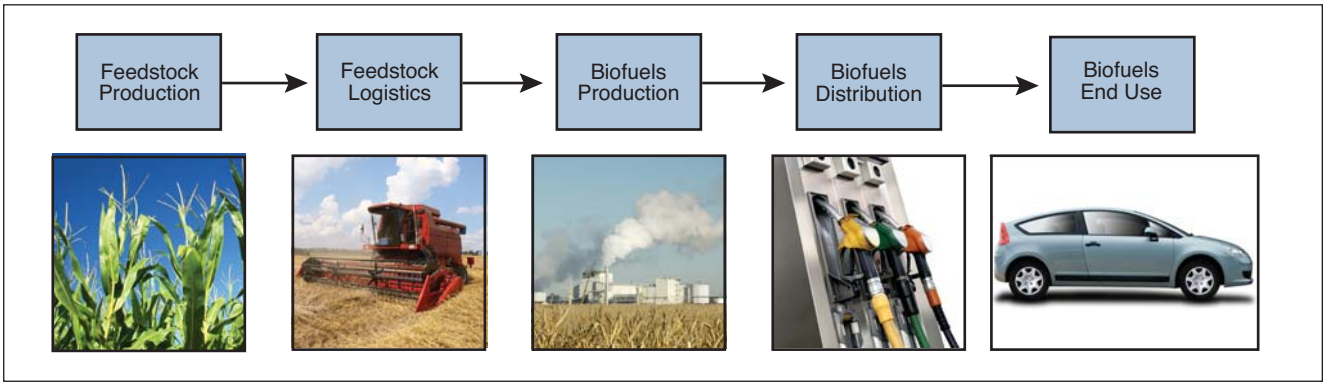

Figure 1. The biofuels supply chain can be analyzed through its five main stages.

and their impacts on agriculture and the environment.

To support EISA and to measure progress toward sustainable biofuel production, federal agencies are collaborating on a host of activities, including developing a set of criteria and indicators for benchmarking and evaluating progress toward a sustainable biofuel system. Agencies will be able to track these important social, economic, environmental, and energy-security criteria and indicators over time to ensure that trends in these elements are moving in the right direction and that corrective actions will be triggered when they may be necessary.

On the business side, biomass producers are sensitive to public concerns about competing uses of biomass for food and fuel, as well as issues related to natural resource protection. They are integrating sustainability objectives into many biofuel business strategies, not only for feedstock conversion, but also for the production of important biofuel co-products. Co-products often find significant new uses in the marketplace, and can generate as much as 25% or more of a conversion facility's revenue. Some biofuel co-products may replace chemicals derived from fossil fuels, reducing the consumption of fossil fuels in chemical manufacturing and thus contributing further to sustainability. Thus, EPA needs to play an important role in partnering with business to ensure that both the development process and end products meet environmental and health standards.

Closing thoughts

Few can argue with the idea of sustainability as a general concept and long-term goal. In making it operational, conflicts can arise over policy, regulations, and business strategies that put sustainability into practice. Evidence exists that government polices and businesses strategies in several areas are, in fact, converging on sustainability (*17*). It is the combination and coordination of activities, the use of diverse regulatory and policy approaches and business strategies, and advances in science and technology that have the potential to promote sustainable biofuel production. Success here would demonstrate critical ways to make sustainability operational in other parts of the energy sector. CEP

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